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(19)

(54) DISTANCE MEASURING EQUIPMENT

(71) We, SMITHS INDUSTRIES LIMITED, a British Company of Cricklewood Works, London, N.W.2., do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to distance measuring equipment and, more particularly, to apparatus for use with an elongate member to measure distances comprising a rotatably mounted member having a circumferential surface which is arranged to be moved along a measurement surface constituted by the elongate member with its circumferential surface frictionally engaging the measurement surface, and means responsive to angular displacement of the member to provide a representation of the distance travelled by the member along the measurement surface.

Heretofor such equipment has been used on, for example, machine tools to measure the distance travelled by a machine tool relative to a work-piece, and in such cases the measurement surface is usually constituted by the bed of the machine tool. However, the bed may not be sufficiently smooth to enable accurate measurements to be obtained of the distance travelled by the rotatably mounted member along the bed. To overcome this it has further been proposed to provide an elongate metal member to constitute the measurement surface, the elongate member being mounted on the machine tool at spaced locations along its length. The elongate member extends between the first mentioned rotatably mounted measuring member and a second rotatably mounted member having a circumferential surface which frictionally engages the elongate member. The two rotatably mounted members are moved together along the elongate member and the second rotatably mounted member serves to ensure that the force with which the first mentioned rotatably mounted member engages the elongate member is substantially constant. Although the provision of the second rotatably mounted member serves to reduce errors in the distance measurement, it has been found that the first mentioned rotatably mounted member tends to slip and that the magnitude of this slip tends to vary with movement of this member along the elongate member. Although the error in the distance measurement caused by this slip is small, it will be appreciated that even small errors may be very important when the distance measuring apparatus is used on, for example, machine tool equipment. Furthermore, such errors are accumulative.

According to one aspect of the present invention there is provided apparatus for use with an elongate member to measure distances, comprising a first rotatably mounted member which has a circumferential surface which is adapted frictionally to engage the elongate member, indicating means responsive to angular movement of the first rotatably mounted member to provide an output representation indicative of the extent of said angular movement, a second rotatably mounted member which has an annular groove of 'V'-shaped cross-section in its circumferential surface which is adapted frictionally to engage said elongate member, spring means for biassing one of said rotatably mounted members towards the other said rotatably mounted member so that the force with which the first member is adapted to engage the elongate member has a component which is to be opposed by a component of the force with which the second member is adapted to engage the elongate member, and a continuously adjustable device arranged to cooperate with said spring means to vary the pressure with which said first and second members are

adapted to engage the elongate member.

It has been found that by so arranging the two rotatably mounted members the aforementioned distance measurement errors may be substantially reduced.

The spring means may be arranged to bias the second member towards the first member.

The rotational axes of said first and second members may be substantially parallel to one another, and the first and second members may be adapted to engage with said elongate member such that in use the rotational axes of said first and second members lie in a plane extending transversely of the longitudinal axis of the elongate member.

The first and second members may be mounted in a casing and the spring means may comprise a spring (e.g. a stack of cooperating belleville washers) acting between a part of the casing and a support member carrying the said second member.

According to another aspect of the present invention there is provided distance measuring equipment comprising apparatus in accordance with the said one aspect of the invention, and an elongate member which is to be frictionally engaged by the said first and second members.

One form of distance measuring equipment in accordance with the present invention will now be described, by way of example, with reference to the accompanying drawings in which:—

Figure 1 is a sectional side view of part of the equipment;

Figure 2 is an end elevation of part of the equipment shown in Figure 1; and

Figure 3 is a sectional side elevation, to an enlarged scale, of a wheel shown in Figure 2.

Referring to the drawings, the distance measuring equipment includes a steel rod 10 which is mounted on, for example, a fixed part of a lathe (not shown) so that the rod 10 extends along a path parallel to the direction of movement of a saddle of the lathe. The rod 10 is mounted at its ends.

A distance measuring apparatus is mounted on the rod 10 and includes a solid, metal roller 11 which frictionally engages the rod 10. The roller 11 is rotatably mounted on a shaft 12 of a transducer 13. Transducer 13 is mounted on the lathe saddle so that the roller 11 is caused to move along the rod 10 in accordance with movement of the lathe saddle. The transducer 13 responds to angular displacement of the shaft 12 to provide an output representation indicative of the extent of angular movement of shaft 12 and hence representative of the distance travelled by the roller 11 along the rod 10. Although the transducer 13 may be of any suitable type it is preferably a moire-fringe transducer as disclosed in U.K. Patent No. 1,138,082.

The rod 10 is urged into frictional engagement with the roller 11 by a wheel 14 which frictionally engages a portion of the rod 10 diametrically opposed to the portion of the rod 10 that engages the roller 11, and which is moved along the rod 10 together with the roller 11. The wheel 14 is mounted so that the rotational axes of the wheel 14 and the roller 11 lie in a plane extending transversely to the longitudinal axis of the rod 10 and the roller 11 and wheel 14 are mounted on the shaft 12 and in the casing 15 respectively so as substantially to prevent relative movement of the wheel 14 and the roller 11 in a direction transversely of the rod 10. More particularly, the wheel 14 is disposed within a casing 15 which is mounted on the transducer 13 and which has apertures through which the rod 10 extends. The wheel 14 has a bearing 16 and is rotatably mounted on a shaft 17 carried by a circular support 18. This support is mounted as a close fit in a circular aperture 19 in the casing 15 so that the wheel 14 extends in a direction normal to the longitudinal axis of the rod 10. Angular movement of the support 18 within the casing 15 is prevented by a pin 20 carried by the casing 15 which projects into a longitudinal groove 21 in the support 18. The end of the support 18 remote from the wheel 14 has a portion of reduced diameter which carries a stack of belleville washers 22. The support 18 is retained within the casing 15 by a screw 23 which engages the end of the stack of belleville washers 22 so as to urge the wheel 14, into frictional engagement with the rod 10 and hence the rod 10 into frictional engagement with the roller 11. As a result, the force with which the roller 11 engages the rod 10 has a component which is opposed by a component of the force with which the wheel 14 engages the rod 10. The roller 11 and the wheel 14 are both of high carbon tool steel and are formed by machining.

The circumferential surface of the wheel 14 is shaped to define an annular recess or groove 24 which engages the rod 10. This groove is of V-shape in cross-section so that, as indicated in Figure 3, the exterior surface of the rod 10 engages both faces of the groove 24.

The roller 11 and the rod 10 are usually of different metals and it has been found that this may cause errors in the distance measurement. It has been found that these errors may be substantially eliminated by appropriately rotating the screw 23 so as to increase the pressure with which the rod 10 engages the roller 11. This increased pressure deforms the roller 11 to decrease the radius of the portion of the roller 11

engaging the rod 10 and so decrease the effective diameter of the roller 11.

In previously known distance measuring apparatus the wheel 14 has been of constant diameter across its width, and it has been found that in such cases the roller 11 tends to slip when it is moved along the rod 10 and that the magnitude of this slip tends to vary with the movement of the roller 11 along the rod 10. It has been found that by providing the groove 24 in the wheel 14, the slip, and hence the resultant error in distance measurement, may be at least substantially reduced. It is believed that this is due to the fact that the V-shaped groove 24 prevents relative movement between, on the one hand, the roller 11 and the wheel 14, and, on the other hand, the rod 10, in a direction transversely of the rod 10.

WHAT WE CLAIM IS:—

1. Apparatus for use with an elongate member to measure distances, comprising a first rotatably mounted member which has a circumferential surface which is adapted frictionally to engage the elongate member, indicating means responsive to angular movement of the first rotatably mounted member to provide an output representation indicative of the extent of said angular movement, a second rotatably mounted member which has an annular groove of 'V'-shaped cross-section in its circumferential surface which is adapted frictionally to engage said elongate member, spring means for biassing one of said rotatably mounted members towards the other said rotatably mounted member so that the force with which the first member is adapted to engage the elongate member has a component which is to be opposed by a component of the force with which the second member is adapted to engage the elongate member, and a continuously adjustable device arranged to cooperate with said spring means to vary the pressure with which said first and second members are adapted to engage the elongate member.

2. Apparatus according to Claim 1 wherein said spring means is arranged to bias the second member towards the first member.

3. Apparatus according to Claim 1 or Claim 2 wherein the rotational axes of said first and second members are substantially parallel to one another.

4. Apparatus according to Claim 3 wherein said first and second members are adapted to engage with said elongate member such that in use the rotational axes of said first and second members lie in a plane extending transversely of the longitudinal axis of the elongate member.

5. Apparatus according to any one of the preceding claims wherein the said first and second members are of metal.

6. Apparatus according to any one of the preceding claims wherein the said first member comprises a roller carried on one end of a shaft, and wherein said indicating means is coupled to the other end of the shaft.

7. Apparatus according to any one of the preceding claims wherein the said first and second members are mounted in a casing and wherein said spring means acts between the said adjustable device and a support member carrying the said second member.

8. Apparatus according to Claim 7 wherein the spring means comprises a stack of co-operating belleville washers.

9. Apparatus according to Claim 7 or Claim 8 wherein the said adjustable device is a screw threaded member mounted in an aperture in the casing.

10. Apparatus substantially as hereinbefore described with reference to the accompanying drawing.

11. Distance measuring equipment comprising apparatus as claimed in any one of the preceding claims and an elongate member which is to be frictionally engaged by the said first and second members.

12. Distance measuring equipment according to Claim 11 wherein said elongate member is circular in cross-section.

13. Distance measuring equipment according to Claim 11 or Claim 12 wherein the elongate member is a solid metal rod.

14. Distance measuring equipment according to any one of Claims 11 to 13, including means for supporting the elongate member at spaced locations along its length.

15. Distance measuring equipment for measuring distances substantially as hereinbefore described with reference to the accompanying drawing.

For the Applicants
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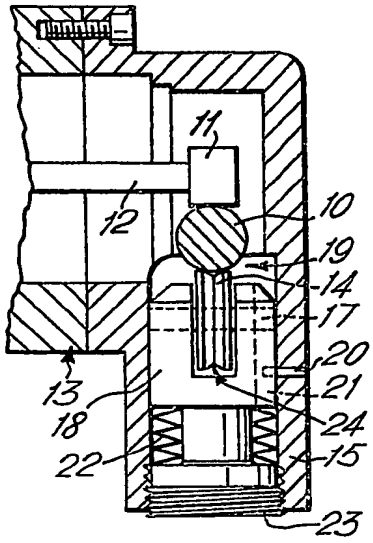
1 SHEET This drawing is a reproduction of the Original on a reduced scale

Fig. 1.



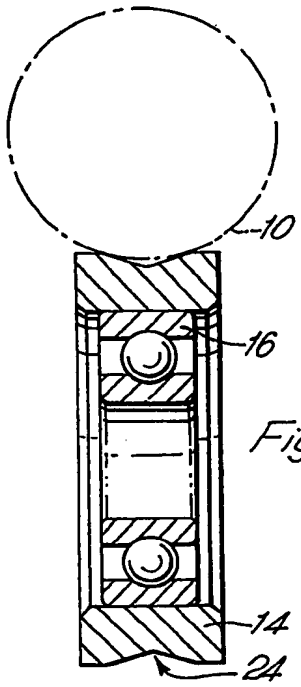


Fig. 3.

Fig. 2.